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A. :Report Title: Affordable Radar Technology: The Defense Perspective

B. DATE Report Downloaded From the Internet _18 Mar 98

C. Report's Point of Contact: (Name, Organization, Address, Office Symbol, & Ph #): The Under Secretary of Defense for Acquisition and Technology

D. Currently Applicable Classification Level: Unclassified

E The foregoing information was compiled and provided by:
DTIC-OCA, Initials:___PM_________**Preparation Date:**18 Mar 98

DIST-A

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"Affordable Radar Technology: The Defense Perspective"

Banquet Address of
The Under Secretary of Defense for Acquisition and Technology
Dr. Paul G. Kaminski
to the
1996 IEEE National Radar Conference
Ann Arbor, Michigan

May 14, 1996

It is a great pleasure to be with you tonight and share a defense perspective on radar technology. In a word, radar systems have become—and will continue to be—indispensable to modern military forces. Our challenge is to keep radar systems affordable through concepts of operations that make sense, system architectures that make equal sense, and acquisition practices that make greater sense than they have in the past.

IMPORTANCE OF RADAR SYSTEMS

When I think about how important radar technologies have become, I am reminded of novelist Graham Green's observation that "there are moments in history when a door opens and lets the future in." For me, such a moment came about two months ago when two JSTARS E-8 aircraft—the airborne component of the Joint Surveillance Targeting Attack Radar System—returned home to the United States from a deployment to the European Command in support of NATO forces in Bosnia.

At that time, I had the opportunity to review some of the accomplishments of the JSTARS deployment in support of Operation JOINT ENDEAVOR. And I was struck by just how indispensable that the continuous surveillance coverage provided by the JSTARS' Moving Target Indicator (MTI) and Synthetic Aperture Radar (SAR) radars were to the initial deployment of the NATO Implementation Force—IFOR.

During the early stages of Operation JOINT ENDEAVOR, the JSTARS aircraft flew 51 missions in the Bosnian theater, covering a total area of 747 million square kilometers—to put this in perspective, that is about 75 times the land area of the United States. On a typical mission, the JSTARS aircraft spent an average of eight and half hours on station; filled up the 60 giga-bytes of mass storage on-board; and acquired about 100 radar images at three meter resolution. There were 38 million total detections and 26,000 total revisits. Over the 51 missions, 6,950 radar service requests were met. The use of JSTARS aircraft—and now Predator unmanned aerial vehicles—signal that "the door has now opened and the future is truly here."

It is a future in which United States forces have an overwhelming ability to take and hold the initiative, increase operational tempo, concentrate firepower at times and places of our choosing, and conclude operations within an opponent's decision cycle time. Precision strike weapons, continuous, all-weather, day-and-night surveillance systems, and advanced command, control and communications systems are the elements of this future vision.

Many of you in the audience recall that the current peace implementation operation was preceded by and made possible by a NATO combat operation. Last summer, this operation—called Operation DELIBERATE FORCE, gave us a hint of what combat will look like in the 21st century when precision strike systems are used in conjunction with continuous surveillance and advanced command and control systems. In DESERT STORM, only two percent of all weapons expended during the air war were precision guided munitions, or PGMs. In Operation DELIBERATE FORCE, they accounted for over 90 percent of all ordnance expended by U.S. forces.

The bomb damage assessment photographs taken last summer in Bosnia bear no resemblance to photos of the past where the target, often undamaged, is surrounded by craters. The photos from Bosnia usually showed one crater where the target used to be, with virtually no collateral damage. We are moving closer to a situation known as "one target, one weapon." It was actually more than one--but less than two--weapons per target in Operation DELIBERATE FORCE. This has been the <u>promise</u> for the past 20 years, now it is becoming a <u>reality</u>.

Our precision strike weapon development focus now is to preserve that accuracy while reducing cost; increasing standoff range; and providing all-weather capability. These are the major imperatives behind our development of systems like the all-weather Joint Direct Attack Munition (JDAM), the Joint Standoff Weapon (JSOW) and the Joint Advanced Standoff Strike Missile (JASSM).

A chess analogy is useful for explaining what this means for the changing nature of warfare—the so-called revolution in military affairs. Today, precision weapons have now made it possible to take any piece on any square of the chessboard with no collateral damage to adjacent squares. Given this one target one weapon capability, commanders now need to know where all one's forces are and where all the targets are on a 100 x 200 kilometer battlefield . This is analogous to seeing all the pieces on the chessboard—something we take for granted when playing chess. Imagine how fast you would win the game if you could see all the pieces on the board, but your opponent could see only his major pieces plus a few of your pawns. This is what it means to have "Dominant Battlefield Awareness." And having a dominant radar surveillance capability will play a central role.

To secure an overwhelming advantage, commanders will also need command, control and communications (C^3) and advanced planning tools to achieve something I call "Dominant Battle Cycle Time" — or the ability to act before an adversary can react. Back to the chess analogy, dominant battle cycle time would be, well, gaining an unfair advantage by breaking the rules — it means to keep moving your pieces without giving your opponent a chance to move his. To do this on the battlefield, one must have superb command, control and communications systems to disseminate knowledge, make decisions and take action.

BOSNIA INFO-COMM OBSERVATIONS

To support IFOR forces in Bosnia, I recently approved spending about $80 million on an information-communications initiative to be sure we have such capabilities for Operation JOINT ENDEAVOR. This initiative is improving our communications capabilities in two ways: first, by using commercial TV satellite technology to provide a direct broadcast communications capability; and secondly, by fielding a wide bandwidth, secure tactical internet connection through fiber and commercial satellite transponders.

These communications allow war planners and logisticians, on the ground in Bosnia, in the European Command Headquarters in Germany and back in the Pentagon to have access to the same data at the same time — this access is available to virtually anyone with a 20 inch receive antenna, cryptologic equipment and authentication codes. We've designed the system in such a way that we are giving local commanders a 5000 mile remote control to select the programming that they receive over their 24 megabits-per-second downlinks from direct broadcast satellites.

There are many striking aspects to this Bosnia Info-Comm initiative. First, we're pushing hard to get the most advanced information capabilities and an effective concept of operations to our forces, and we are succeeding. We've accomplished in four months what it normally takes ten years to do for a new system. Second, we are proving the need to possess system engineering and system integration skills. And third, we are demonstrating our willingness to use — even to lease — commercial systems.

I believe each of these three major observations — the need for an effective concept of operations, compatible system architectures, and acquisition approaches that leverage the commercial industrial base — are three of the keys to affordable radar technology systems.

AN AFFORDABLE CONOPS

If we look first at the concept of operations—the CONOPS—for exploitation of the product from wide-area sensors, I think you will find that the marriage technology and employment doctrine is one thing that has not been given adequate emphasis in the past. We have traditionally underestimated the importance of developing the appropriate doctrine, the tactics for employment, the training, and the people using these technologically advanced systems.

We really have two CONOPS related affordability problems. The first is that our ability to collect a flood of imagery—radar-based and otherwise—will place an increasing insurmountable workload burden on image analysts if we continue to use the current exploitation approach. Our second CONOPS problem is that we have not yet developed an efficient process for managing the collection of imagery from a distributed network of sensors and processors.

Turning to the first problem—the ability of image analysts to deal with a "flood" of collected imagery. We have to reduce the image analyst's workload burden if we expect to have continuous, near-real time surveillance of the battlefield. Part of the solution will be the development use automated and semi-automated target recognition tools. More importantly, we will need to develop the operational target cueing techniques and procedures to aid the analyst in using an integrated approach for detecting, discriminating, classifying and tracking both stationary and moving targets.

The Defense Advanced Research Projects Agency is running an Advanced Concept Technology Demonstration—an ACTD—called Semi-Automated IMINT Processing. This demonstration seeks to reduce the image analyst's workload for stationary target exploitation by a factor of a thousand. A similar ACTD is planned to wring out operational implementation of a moving target exploitation system. The end objective will be to synergistically exploit synthetic aperture and moving target indicator radar capabilities in a single, integrated concept of operations.

Turning to our second CONOPS problem—managing the collection of imagery, our exploitation goal is to assess the battlefield situation, nominate targets, and manage collection resources by efficiently correlating, tracking and cross-cueing all collection assets. You can think of this concept in terms of selecting the right spectral frequencies. . . over the right area and resolution. . . and doing this over the right period of time.

We are now planning to make tenfold improvements in multi-spectral sampling, through combinations of radar, infra-red and electro-optical wavelengths, while at the same time, making a tenfold increase in the area of resolution of collection systems, and then on top of this, making a tenfold improvement in the continuity of coverage,

moving towards around-the-clock day-and-night coverage under all weather conditions.

(Chart One On)

The problem is that if we make all these improvements simultaneously, we are looking at a ten times ten times ten, or thousand fold increases in the data to be analyzed and processed for the user. That is probably not something we can deal with. Neither could we probably afford the full combination of collection systems.

So the idea is not to apply—in an operational context—all the improvements simultaneously. The concept is to be able to operate sequentially, to do some sampling, with technologies that may in a sensible way pick the appropriate path. . . in the appropriate spectral frequency band. . . over the area of interest at the proper resolution. . . and at the right time interval. . . to produce information that can be suitably digested and acted upon.

The idea is illustrated in this chart. Smart sequential tasking allows us to chart an appropriate path in three dimensions rather than fill the whole volume.

(Chart One Off)

SENSIBLE ARCHITECTURES

In addition to operations concepts that make sense, we must implement system architectures that make sense as well. The overall affordability of radar systems will, in part, depend on the architectural tradeoffs we make in areas like high resolution sensors and digital image processing.

(Chart Two On)

For example, if I wish to detect a target like an M48 tank at a given radar line of sight, I can invest in a sensor that gives me one meter resolution or a more expensive one that gives me half meter resolution. The more expensive half meter resolution sensor will produce an image that increases the probability of target detection with a much lower false alarm generation rate.

But if I use lower cost High Definition Scalar Imaging techniques—super resolution digital processing—to enhance the image, I can improve my target recognition performance. In some cases, high definition scalar image processing of one meter data can approximate conventionally processed half meter data.

(Chart Two Off - Chart Three On)

In cases where I am trying to detect Transporter-Erector-Launcher targets—relatively long length targets—at a rate of three false alarms per square kilometer, typical automatic target recognition performance is pretty good—about 99 percent—for conventional image formation with one meter resolution data.

But if I wish to lower my false alarm rate by two orders of magnitude, my probability of detection drops off to below 55 percent for conventionally processed one meter data. For conventionally processed half meter data, the probability of detection is still quite good—a little over 95 percent.

If I pursue a less expensive architectural option—one in which I employ high definition scalar image processing of one meter data, my probability of detection is roughly equivalent—a little under 95 percent—at the same low rate of false alarms per square kilometer.

(Chart Three Off - Chart Four On)

High definition scalar image processing improves the automatic target recognition of smaller tactical targets—cases where there will be less pixels on target for a given level of resolution. If I incorporate group reasoning techniques in my exploitation architecture, I can dramatically improve my probability of detection at lower rates of false alarms per square kilometer.

Group reasoning improves performance using knowledge about an adversary's deployment patterns. For example, if I know from force structure analysis that an adversary typically deploys a company of ten tanks in a standard defensive or attack pattern, then I can use this information to pick out all ten tanks even when only eight are positively identified along with several false alarms.

(Chart Four Off)

Without a doubt, we can help develop affordable system architectures by applying our systems engineering and integration skills to substitute low cost solutions in place of high cost "brute force" approaches.

In addition, we need to think in terms of modular components and open standards when architecting system solutions. Distributed and open architectures will preserve competition and reduce the cost of transition to more modern technologies. For these reasons, the Department is firmly committed to "plug and play" architectures in which a variety of collection systems can play together in a compatible way.

EXPANDING THE INDUSTRIAL BASE

In addition to the need for effective concepts of operations and compatible system architectures, the third key to affordable radar systems is the need to pursue acquisition approaches that leverage the broadest possible commercial industrial base. One of the principal objectives of our acquisition reform program is to open the defense market to commercial companies and technology—not only the primes, but sub-tier suppliers as well.

A tighter linkage with commercial markets can shorten the cycle time for weapon system development and reduce the cost of inserting technological improvements into DOD weapon systems. The Department's costs are reduced by leveraging the commercial sector's investment in the underlying radar technology base as well as on-going production lines for modular components and sub-assemblies.

Knocking down the barriers to commercial products eliminates the cost associated with government imposed regulations and standards. A recent Coopers and Lybrand study estimated that the DoD-imposed regulatory cost premium to be on the order of 15 to 20 percent of total cost.

It is also clear to me that we will have to leverage the industrial base of our allies and reliable friends as well to modernize our forces at an affordable cost. In particular, I believe we will need to avoid the inclination to duplicate each other's capabilities. Instead, we need to think in terms of building on developed capability where possible.

To do this, we need to harmonize requirements from the start and increase the incentives for teaming of our industry—including removing the barriers to international teaming and barriers to commercial industry as well. We need to start doing this much earlier in the initial stages for our new programs.

(Chart Five On)

We are attempting to apply these principles in pursuit of a cooperative international program to provide NATO with Alliance Ground Surveillance. In March of 1993, the Conference of National Armaments Directors—the CNAD—began exploring possibilities for a common Alliance approach to an effective ground surveillance capability. In June of 1995, the United States hosted—in Colorado Springs—the first ever offsite meeting of the NATO national armaments directors. By the end of 1995, an initial project structure, consisting of a Steering Committee and an Embryonic Program Office, had been established.

We looked at three ownership options over the past year:

- Interoperable national systems;
- A common Alliance ground station architecture; and
- A NATO-owned, jointly operated system.

The CNAD has approved a variation of this last option, choosing "a minimum essential NATO-owned and operated core capability supplemented by interoperable national assets."

Securing an agreement on a common approach to developing such a system of systems has been difficult, but I see a path ahead—actually a dual track—one in which we nail down the system of systems requirement and its urgency while preserving a path to plan for system selection in the Fall of 1997.

(Chart Five Off)

SUMMARY

In summary, radar technology and systems remain indispensable to modern combat and peace implementation operations. Radar systems will be providing mission planners in Bosnia with products ranging from elevation terrain data to real time indication of moving targets.

Our challenge is to provide these products at an affordable cost. I believe there are three keys to developing and fielding affordable radar systems. The first is an effective concept of operations—to accomplish the wide-area surveillance mission, we must look at operational concepts for synergistic exploitation and sequential tasking of distributed collection assets.

The second key is a sensible system architecture—we must avoid architectures containing "brute force" and proprietary approaches to achieve our system performance goals. We will provide commanders with a fused picture of the battlefield when we effectively integrate complementary "plug and play" sensors in an overarching system-of-systems architecture—one containing a central nervous system. And finally, the third key is to adopt acquisition practices that leverage the broadest possible commercial and international industrial base.

The Department is taking action on all three fronts to ensure that U.S. forces in the 21st century have continued access to leading edge radar technologies and systems.

Thank you all.